

# Atomic Absorption Spectrometry

**A**tomic absorption spectrometry (AAS) allows the quantitative determination of elements from major constituent to parts-per-million levels. Flameless techniques that give higher sensitivity are available for some elements. AAS is particularly well suited to analysis of solutions when a relative precision and accuracy of 1 to 2% is desired and one or a few elements are to be measured in the sample.

## Principle of Technique

Samples are introduced into a flame, typically as a nebulized solution. The solvent evaporates, and the solute dissociates into a collection of free atoms. A beam of light, from a lamp fabricated for the element of interest, passes through the vaporized atoms. The light beam intensity at a wavelength characteristic for the element of interest is compared with and without analyte in the flame. Light absorption is then related to the concentration of analyte atoms in the atom reservoir, and thus the original solution by the Beer-Lambert law. A comparison against a series of standard solutions containing the element to be determined provides a quantitative analysis.

## Samples

**Form.** Liquids, usually aqueous solutions, can be analyzed as received or after dilution.

**Size.** From 3 to 5 mL of solution is required for routine analysis. The minimum amount of analyte required is dependent on the element to be determined. A sample that yields 1–100 µg of analyte is generally required. Smaller quantities of analyte (down to a few nanograms) can be accommodated for some elements by using flameless

techniques. When available, microgram quantities of material facilitate sample handling.

**Preparation.** Solids must be dissolved in a suitable medium, usually an acidic, aqueous solution. Liquids are diluted to match the range of standards used.

## Limitations

Individual sources are required for each element measured. Atomic absorption is inherently a single-element (not scanning) technology. Solid materials must be dissolved in an aqueous solution. No structural or oxidation state information is needed or generated.

## Estimated Analysis Time

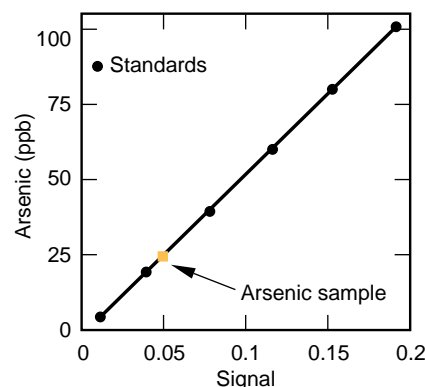
Including instrument startup time, qualitative analysis of a single solution requires about 2 h. Usually 3 to 4 h is needed for preparation of samples and standards for a quantitative analysis.

## Capabilities of Related Techniques

Plasma optical emission spectrometry techniques (inductively-coupled-plasma emission spectroscopy and DC-plasma optical emission spectroscopy) are multielement techniques (i.e., several elements can be

## Examples of Applications

- Analysis of alkali metal and alkaline-earth elements in soil and water samples.
- Monitoring mandated metals and metalloids in hazardous waste samples.



Arsenic is detected in retention tank water at the 25-ppb level by graphite furnace AAS.

determined efficiently at the same time). Inductively-coupled plasma mass spectrometry is also a multielement method applicable to elements present at very low levels. Choice of method depends on the number and identity of elements present and on the number and identity of elements to be determined.

Classical solution chemistry techniques may be applicable to certain samples when macroscopic quantities

of material are available. These techniques are usually capable of high accuracy and precision, but they can be labor intensive.

DC-arc optical emission spectroscopy and x-ray fluorescence spectrometry may be applicable, and can be used to analyze solids directly without dissolution. Detection limits, however, are usually inferior, as is quantitation.

(H)																										(H)	(He)
Li 0.5	Be 2																										
Na 0.2	Mg 0.1																										
K 1	Ca 1	Sc 20	Ti 50	V 40	Cr 2	Mn 1	Fe 5	Co 6	Ni 4	Cu 1	Zn 1	Ga 50	Ge 100	As 20	Se 100	(Br)	(Kr)										
Rb 2	Sr 2	Y	Zr 500	Nb 1000	Mo 30	(Tc)	Ru	Rh 10	Pd 15	Ag 1	Cd 0.5	In 20	Sn 20	Sb 3	Te 20	(I)	(Xe)										
(Cs)	Ba 10	La 2000	Hf	Ta 1000	W 1000	Re	Os	Ir	Pt 40	Au 5	Hg 200	Tl 10	Pb 10	Bi 20	(Po)	(At)	(Rn)										
(Fr)	(Ra)	(Ac)	(Rf)	(Ha)																							

Ce	Pr	Nd	(Pm)	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	(Pa)	U 10000	(Np)	(Pu)	(Am)	(Cm)	(Bk)	(Cf)	(Es)	(Fm)	(Md)	(No)	(Lr)

Detection limits for flame source AAS for simple aqueous solutions. Quantitation limits are typically 10 times the detection limit. Elements not typically determined by flame AAS are in parentheses.